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ABSTRACT

This technical document focuses on the Department of Energy's (DOE) efforts to restore the environment and manage nuclear waste. This student edition was rewritten and edited by a team of high school students in order to make it "user-friendly" for high school students and the general public. The document focuses on the efforts of the Office of Environmental Restoration and Waste Management (EM) to clean up the current inventory of inactive and nuclear-related sties and facilities. The document contains the following: (1) introduction; (2) changes in attitudes at the DOE; (2) how EM is structured; (3) the definition of environmental restoration and waste management; (4) DOE's 30-year clean-up goal; (5) DOE's 5-year plan; (6) types of waste that EM manages and how it is stored; (7) a definition of radiation; (8) a description of how the waste is managed; (9) corrective activities that bring facilities into compliance with regulations; (10) remedial actions and decontamination and decommissioning; (11) technology development; (12) methods for the transportation of radioactive and hazardous materials; (13) facility transition and management; and (14) EM educational opportunities. Diagrams and color pictures illustrate the text. (LZ)

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ENVIRONMENTAL

RESTORATION AND WASTE MANAGEMENT

AN INTRODUCTION

STUDENT EDITION

BEST COPY AVAILABLE

DOE/EM-0104

This document was prepared by the
Scientific and Technical Writing Class
Oak Hills High School
Cincinnati, Ohio

Oak Hills High School

3200 Ebenezer Road • Cincinnati • Ohio • 45248 • (513) 922-2300

Principal: James E. Williamson

Assistant Principals: Franklin L. Shaut • Dana L. Stutzman • Rod W. Bauer

The document you hold in your hands is the result of months of learning, reading, writing, and more writing. Our goal is to help the Department of Energy (DOE) clearly present to you its monumental task to clean up 40 years of nuclear waste. We hope that by the time you read the final page of this document you'll agree we succeeded.

What brought a group of Cincinnati, Ohio, high school students to this point? In October 1992, our school, like hundreds of others, received a letter from DOE looking for teams of high school students to condense and simplify their existing book, ***Environmental Restoration and Waste Management: An Introduction****. The specific task was to rewrite this technical document, making it "reader-friendly" for high school students and the general public.*

As a scientific and technical writing class, the job seemed perfect for us. We used our skills to edit, clarify, and eliminate difficult jargon. We also integrated text and pictures more fully and made the tone more conversational. Because our revision was chosen as the best of seven finalists by a panel of DOE-sponsored judges, we were given the opportunity to complete the book in Washington, D.C., in April 1993.

This process has taught us so many things – the fine points of technical writing, the ups and downs of working as a team, the difficulties of meeting deadlines, the sweet taste of success, and the great taste of a hot pizza on cold Saturday afternoons while working on the book. What we have learned about the environment has been an education in itself. Living close to a DOE site located in Fernald, Ohio, we have become especially sensitive to DOE's job of restoring the environment and managing nuclear waste. But we also know the problem isn't just local; it's national. No matter where you live, the task of environmental restoration and waste management affects you.

Before you turn the page and begin reading, we'd like to recognize and thank the people from Fernald whose unfailing support and countless hours given to everything from content, to pictures, to creative ideas are deeply appreciated.

Read, learn, and get involved. The future depends on all of us.

Chris Giesting
Michele Braunstein
Michelle Stanzfield

Dan Hoerst
Cindie Sucher
Jenny Fuller
Trisha Agnes
Brian Hock

Jon Erdmann
Tom VonHoene

Mrs. Trish Bollish
(Teacher)

Mrs. Cheryl Burt
(Advisor)

Proclamation

We the People

of the Department of Energy, in order to form a more perfect environment, establish a long-term compliance and cleanup goal, ensure public safety, provide for the treatment of contaminated waste, promote public involvement, and secure the trust of the public, do establish the Office of Environmental Restoration and Waste Management.

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Introduction

For more than 40 years, the United States has produced nuclear weapons. These production activities generated both radioactive and hazardous waste and often contaminated the environment. For many years, the public was unaware of the problem and unable to do anything about it. All of this has changed.

In response to recent public outcry, the former Secretary of Energy, Retired Admiral James D. Watkins, established the Office of Environmental Restoration and Waste Management (EM) in November 1989. The creation of EM was the first step toward correcting contamination problems from the past 40 years.

The Clinton Administration has appointed a new Secretary, Hazel R. O'Leary, whose vision of the Department of Energy (DOE) is integrating what she calls the four E's: energy, environment, economic issues, and education. She sees these four elements "woven together in a pattern and a tapestry that supports this Nation." Secretary O'Leary's commitment to EM is very strong, and she promises that the effort will be one of DOE's highest priorities.

In this booklet, we at DOE, through the efforts of the Oak Hills High School students, will introduce you to EM and encourage your involvement in this major program within the Department of Energy.

"We are brothers of the whooping cranes...The fact of our brotherhood is a zoological fact,ecological fact, everlasting earth-fact: and we are to forget it only at our grave peril. [When the] web of nature's being is anywhere broken or seriously disturbed, the effect travels throughout the whole of things, man not excepted."

Alan DeVoe

What's 'IN' and What's 'OUT' at DOE?

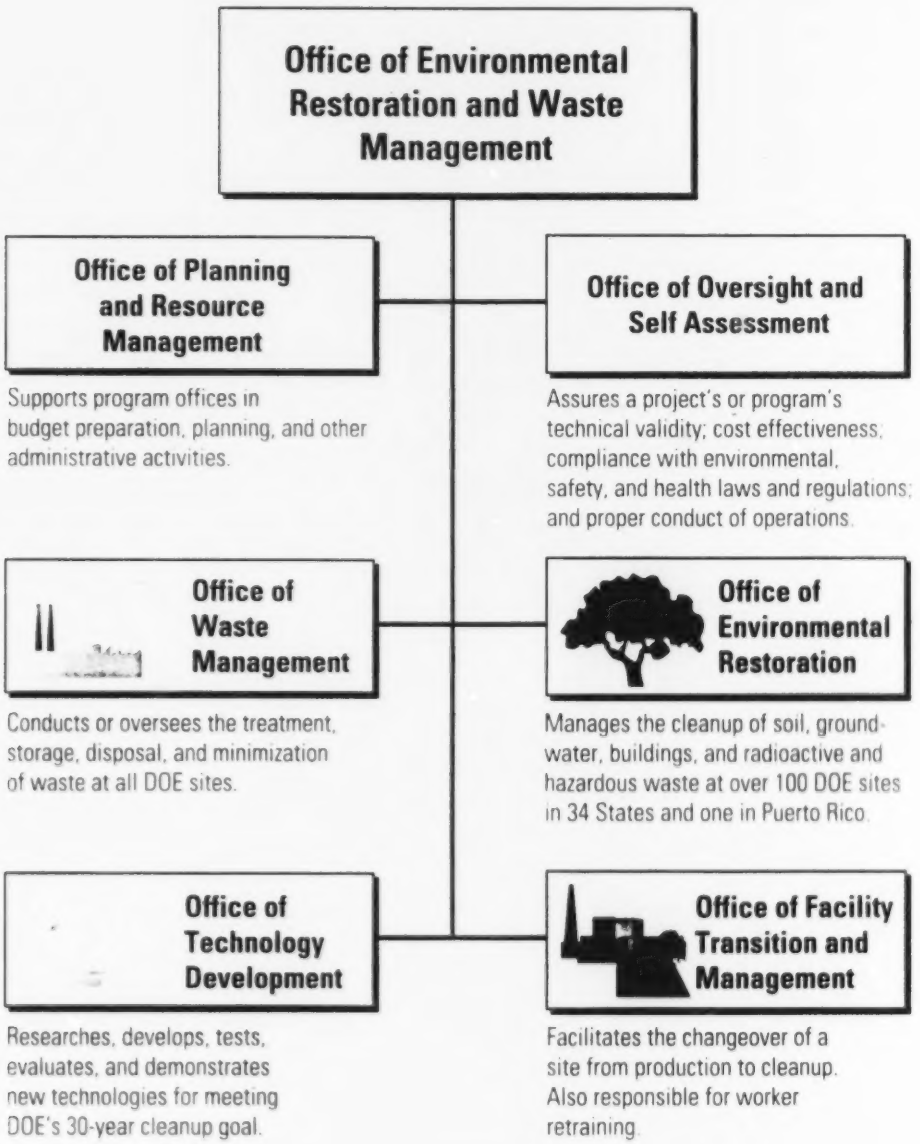
The most important thing for you to keep in mind is that the creation of EM represents a change in attitude at DOE. The old hands-off "trust-me" culture has been replaced with a hands-on "watch-me" and "join-me" culture.

Responding to public demand	**Ignoring public demand**
Including the public in decisionmaking	**Leaving the public out of decisionmaking**
Cleaning up the environment	**Polluting the environment**
Reducing waste generation	**Producing unlimited waste**
Making waste management a high priority	**Making waste management a low priority**
Handling waste through EM	**Handling waste through different organizations of DOE**
Five-Year Plan, Thirty-Year Goal	**Not planning for the future**

We will stop polluting the environment!
We will clean up our mess!
We will stop polluting the environment!
We will clean up our mess!

How Is EM Structured?

Before EM was created, several DOE organizations were handling waste. EM represents a consolidation of these efforts. Like many other large organizations, its duties are divided among several offices.

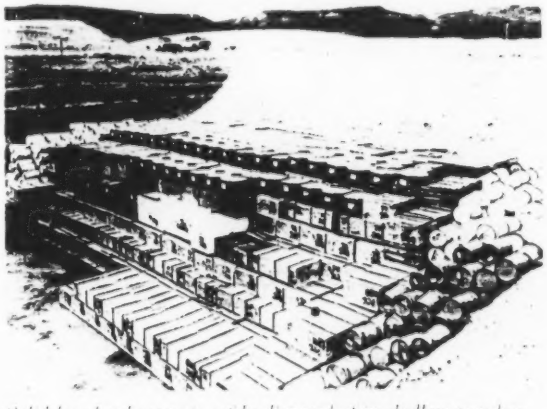

Office of Environmental Restoration and Waste Management
Office of Planning and Resource Management
Supports program offices in budget preparation, planning, and other administrative activities.
Office of Oversight and Self Assessment
Assures a project's or program's technical validity; cost effectiveness; compliance with environmental, safety, and health laws and regulations; and proper conduct of operations.
Office of Waste Management
Conducts or oversees the treatment, storage, disposal, and minimization of waste at all DOE sites.
Office of Environmental Restoration
Manages the cleanup of soil, groundwater, buildings, and radioactive and hazardous waste at over 100 DOE sites in 34 States and one in Puerto Rico.
Office of Technology Development
Researches, develops, tests, evaluates, and demonstrates new technologies for meeting DOE's 30-year cleanup goal.
Office of Facility Transition and Management
Facilitates the changeover of a site from production to cleanup. Also responsible for worker retraining.

What Is Environmental Restoration and Waste Management?

The problems we're discussing are the result of over 40 years of producing materials for nuclear weapons. That's 40 years of accumulated waste and unchecked contamination of the environment. That's a big problem for EM to tackle.

Environmental Restoration (ER) is the cleanup and restoration of sites contaminated with radioactive and hazardous substances as a result of past operations connected with DOE nuclear programs.

Waste Management (WM) involves ongoing activities for safely reducing, treating, storing, recycling, and disposing of all waste while protecting you and the environment.



Solid low-level waste is safely disposed of in shallow trenches. When the trench is full, a protective covering for erosion control will be placed on top.

The teal color in Kerr Hollow Quarry is the result of disposal of water-reactive waste and gasses that were placed in containers and sent down a ramp to the bottom of the quarry. The quarry is presently being cleaned up.

The crane lowers the yellow remotely-operated vehicle, called a SONSUB, into Kerr Hollow Quarry to perform an underwater inspection of the containers.

What Is DOE's Thirty-Year Goal?

Now that you know what EM is, why it was created, what its long-term goal is, and how it is organized, it's time to focus on how you can participate in solving the problems.

Let's look at the big picture - what EM intends to accomplish in the long run. Problems that took 40 years to create can't be solved overnight. EM is looking at a time frame of 30 years to reach the goal of cleaning up the current inventory of inactive and nuclear-related sites and facilities. EM strives to do this by the year 2019 while following applicable Federal, State, and local laws and regulations.

There are over 100 contaminated DOE sites throughout the country. We are all affected: we all feel the impact of the problem. Likewise, we all feel the impact of the process of solving the problem.

What is the Five-Year Plan?

The Five-Year Plan outlines the stages for EM to clean up and restore contaminated DOE sites. It specifies the plans for the upcoming year and then projects plans and goals for the next four years. The Five-Year Plan is written for you, the public, and includes your input to ensure that you are involved in the process. EM updates the Five-Year Plan annually to reflect changing government conditions, improved technology, and public concerns. The strategies for the Five-Year Plan involve:

- focusing activities on eliminating or reducing known or recognized risks to workers, the public, and the environment;
- containing, isolating, and/or removing onsite and offsite contamination;
- developing technology to achieve environmental goals; and
- satisfying all agreements made with Federal and State agencies.

Because we are all affected, it is important that we involve you, the public, in our activities. National groups such as the State and Tribal Government Working Group (STGWG) and the Stakeholders' Forum provide input into DOE activities. Made up of representatives appointed by governors and Tribal leaders from State and Tribal lands hosting DOE sites and facilities, STGWG also includes representatives from the National Governors' Association, the National Conference of State Legislatures, and the National Association of Attorneys General.

The Stakeholders' Forum is made up of some STGWG members as well as representatives from Federal agencies, public interest groups, university consortia, management and operating contractors, industry groups, teachers, and others. The Forum provides input into the Five-Year Plan and communicates with DOE on issues relating to the Five-Year Plan.

What do these groups do? How can they actually influence the policies and activities of EM? Read on!

Previously at Fernald, materials such as scrap metals, vehicles, structural steel, and equipment were placed in piles.

As a final activity, the scrap metal pile is recycled and the area is cleaned up.

Office of Waste Management

By now you've read several references to EM's goal of managing waste. It's time to explain just what EM does and how EM does it.

What Types of Waste Does EM Manage?

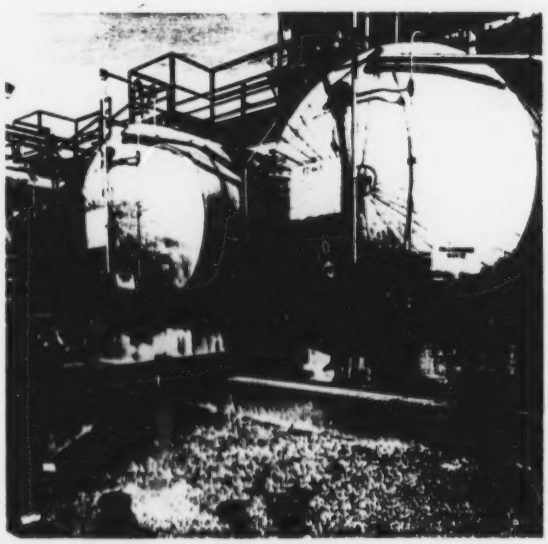
EM manages the following types of waste:

- High-level waste
- Transuranic waste
- Low-level waste
- Uranium mill tailings
- Hazardous waste
- Mixed waste
- Sanitary waste
- Contaminated soil and ground water

Radioactive Waste

High-Level Waste - the highly radioactive material resulting from the reprocessing of used nuclear fuel. This includes liquid waste produced directly from reprocessing and any solid waste derived from the liquid that contains a combination of radionuclides with concentrations high enough to require permanent isolation.

Transuranic Waste - low-level waste material contaminated with alpha particle emitting isotopes with half-lives greater than 30 years exceeding a particular concentration. This is produced during reactor fuel assembly, nuclear weapons fabrication, and fuel reprocessing operations. It contains man-made elements heavier than uranium, thus the name transuranic, or "beyond uranic."



Hazardous waste in storage awaiting treatment.

Lime softening of water produces a sludge.

Low-Level Waste - radioactive waste that does not fall into any other category. Low-level waste is usually rags, papers, filters, tools, equipment, and discarded protective clothing.

Uranium Mill Tailings - naturally occurring radioactive rock and soil that are the result of uranium mining. Tailings may also contain other minerals or metals not extracted in the mining process.

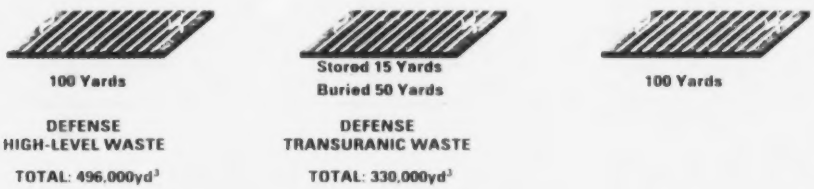
Other Types of Waste

Hazardous Waste - toxic, corrosive, reactive, or ignitable substances that can affect health and damage the environment.

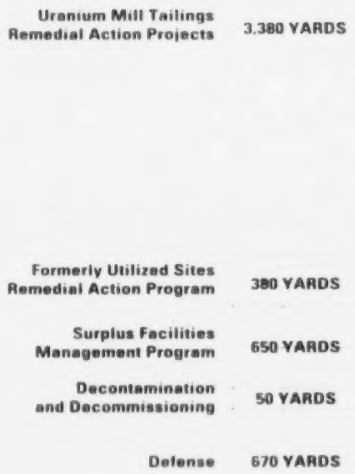
Mixed Waste - contains both radioactive and hazardous components.

Sanitary Waste - generated by normal housekeeping activities and contains neither radioactive nor hazardous waste.

Contaminated Soil and Ground Water - soils and ground water contaminated with radioactive materials, hazardous chemicals, or both.

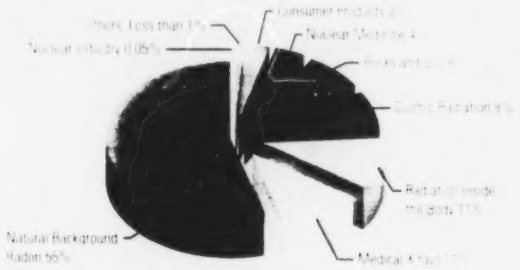


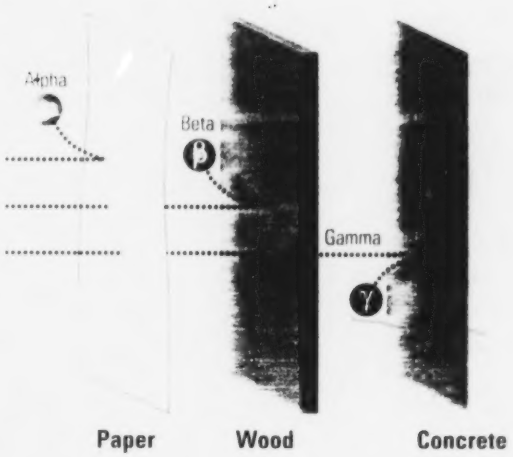
If all DOE waste produced as of December 31, 1989, was combined to fill football-field-size areas, high-level waste would fill a hole about 100 yards deep and transuranic waste would fill a hole about 65 yards deep. Low-level waste would fill a hole about 9,000 yards (about 6 miles) deep. There is about 55 times as much low-level waste as high-level waste and transuranic waste combined.



What Is Radiation?

Radiation is a natural part of our environment. Many materials, both natural and manmade, are radioactive. By releasing radioactive particles, unstable radioactive materials decay into stable, non-radioactive substances. Depending on the material, the decay process can take from a fraction of a second to billions of years. Many different sources of radiation are outlined in the pie chart below.

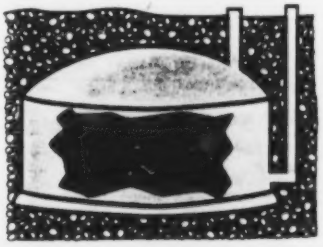




There are three principal types of radiation: alpha, beta, and gamma. Humans and the environment can be shielded from radiation using different materials. Alpha radiation can be shielded by a sheet of paper and will not penetrate skin. Beta radiation can pass through an inch of water and human flesh, but it can be shielded by a thin sheet of aluminum, plywood, or steel. Gamma radiation is the most dangerous and can pass through many materials including the human body. Dense materials such as lead or concrete must be used to shield gamma rays.

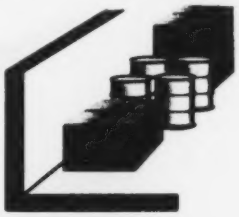
When EM is deciding how to handle, store, transport, and dispose of nuclear waste, the type and level of radioactivity is very important. EM must use the proper containers and equipment to prevent leakage of radioactive particles and to protect the public from exposure to radiation.

Liquid waste from reprocessing plants can be converted to sludge or immobilized in solids for handling and storage purposes. Contaminated materials, such as empty containers, protective clothing, and used equipment, are compacted and stored in metal drums or wooden boxes.



High-level waste needs heavy shielding to confine penetrating radiation and dissipate heat.

Radiation from most transuranic waste is blocked by a storage container.



Engineered barriers can effectively isolate low-level waste from the environment.

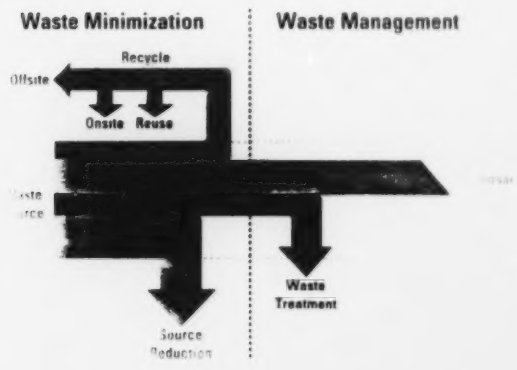
How Is the Waste Managed?

What EM does with waste depends on its type and volume. But the goal is constant: to safely manage and dispose of all our waste while protecting you and the environment.

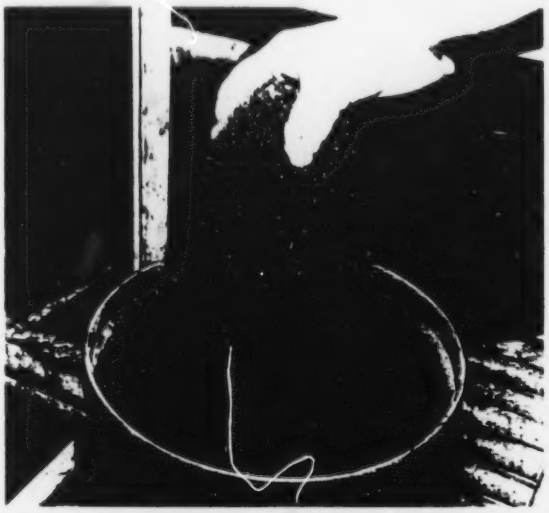
Waste Minimization ➡ Although reducing waste volume and concentration is part of the effort, true waste minimization begins with reducing the amount generated. The objective is to reduce the toxicity as well as 50 to 80 percent of the volume of waste generated. This will help reduce the need for waste treatment, storage, and disposal, and will lower health risks. Waste minimization is accomplished by:

- ***Substituting materials*** - using nonhazardous and environmentally safe chemicals;
- ***Altering processes*** - reducing the number of production steps;
- ***Producing new hardware*** - designing products, methods, and facilities to reduce the amount of excess waste; and
- ***Recycling*** - finding ways to recycle all materials and using recyclable chemicals and products.

Waste Reduction



The major focus of waste minimization is reducing the amount of waste from the source. In doing so, the amount of waste requiring treatment and/or disposal is also reduced.

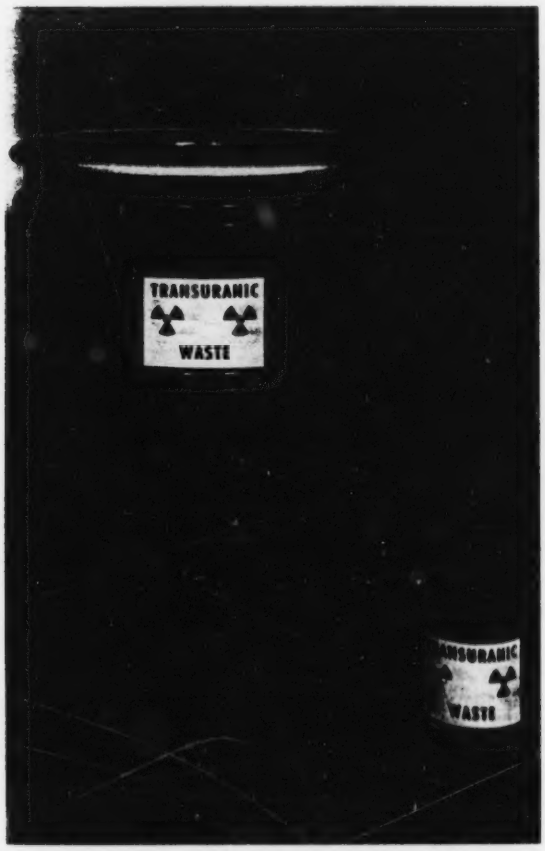


Uranium recycling will reduce waste volume and lower waste treatment, storage, and disposal costs. Scrap is processed and compacted into billets that are reused.

Worker uses rubber gloves to handle newly recovered uranium. The uranium recovered by this system can be reused with lower overall waste handling cost.

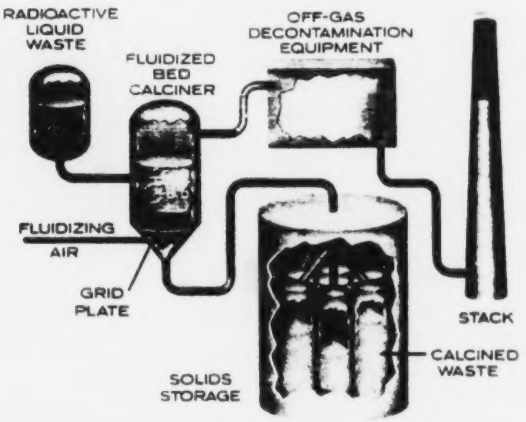
Treatment Waste is treated to reduce volume or toxicity for safer handling. Treatment methods are chosen based on the amount and the form of the waste. Although few mixed waste treatments have been established, Congress approved four new specific waste treatment standards for mixed waste containing mercury, lead, powdered zirconium, and high-level radioactive waste. Types of treatment methods include:

- ***Incineration*** – uses combustion to reduce the volume of waste and to destroy many hazardous substances;
- ***Solidification*** – uses methods such as calcining to stabilize and prepare nonsolid radioactive waste for disposal; and
- ***Vitrification*** – converts high-level liquid waste into a stable, solid form by mixing it with molten glass.



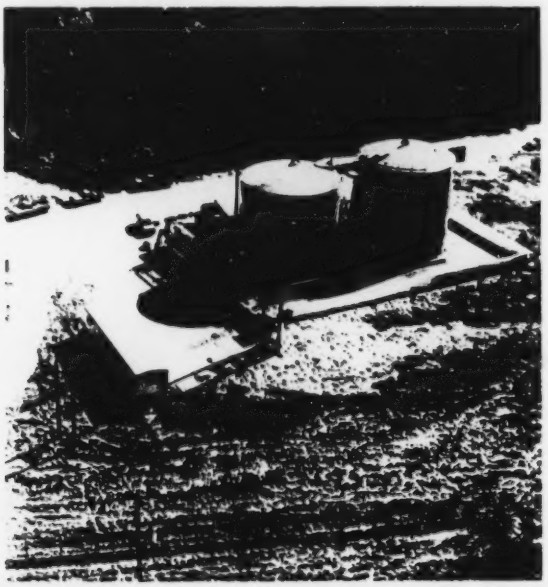
After treatment, the contents of the large drum will fit into the smaller drum.

Buried nuclear waste has been stabilized by in situ (in place) vitrification. The waste and the surrounding rock and soil melt together into a durable black glass product as shown.

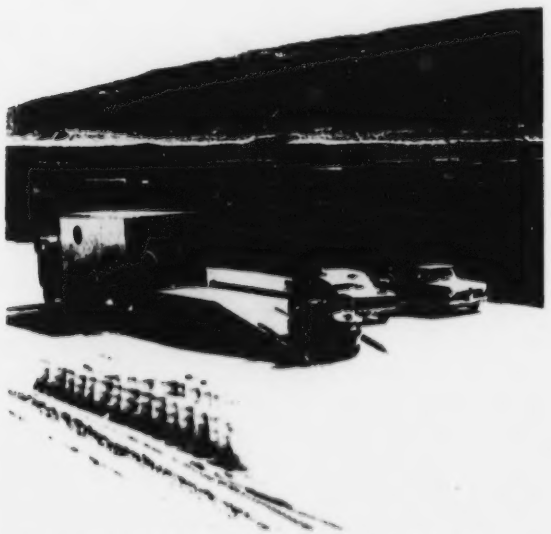


The New Waste Calcining Facility (NWCF) in Idaho treats high-level waste by a type of solidification called calcining. Liquid waste droplets are sprayed onto hot particles, removing their moisture. This turns the liquid waste into granules or powder that is then poured into stainless-steel bins having a life span of hundreds of years. The bins are enclosed in underground vaults.

Storage Waste is temporarily stored and awaits treatment until permanent disposal facilities are available. Waste is usually treated before storage. However, untreated waste is sometimes stored in anticipation of better treatment processes or while awaiting the availability of treatment facilities. The long-term goal is to end storage and begin permanent disposal.



Liquid low-level waste can be stored in tanks awaiting treatment and/or disposal.

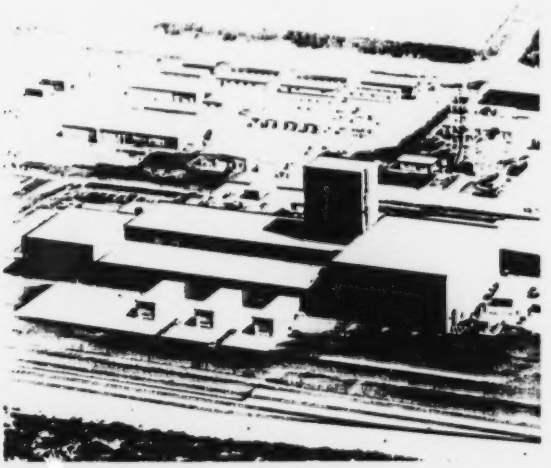


Stacks of solid nuclear waste storage containers at a shallow land burial site.

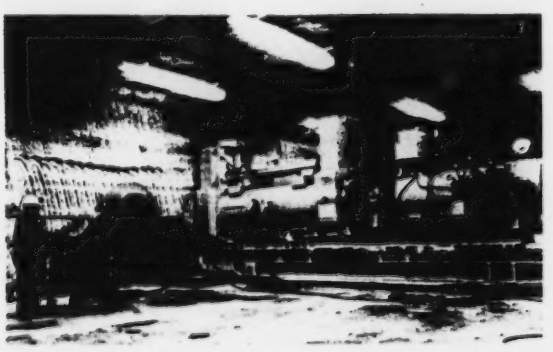
Disposal Waste is disposed of to permanently isolate it from people and the environment. Most disposal is accomplished by burial. The type of waste determines the type of burial.

The Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico, is a facility designed for the disposal of transuranic waste. The waste will be disposed of 2,150 feet below ground in 225-million-year-old salt deposits.

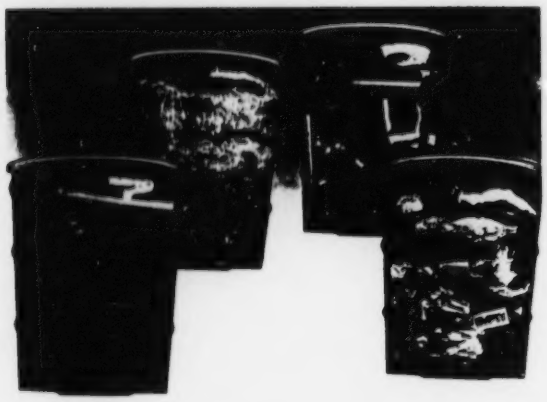
While the aboveground plant covers only 100 acres, the subterranean disposal site spans 10,240 acres! This will allow WIPP to dispose of up to 6.45 million cubic feet of waste in each of its 4 shafts. This amount of waste would fill between 14,000-15,000 aboveground swimming pools with a diameter of 24 feet.



Aboveground facilities at WIPP.

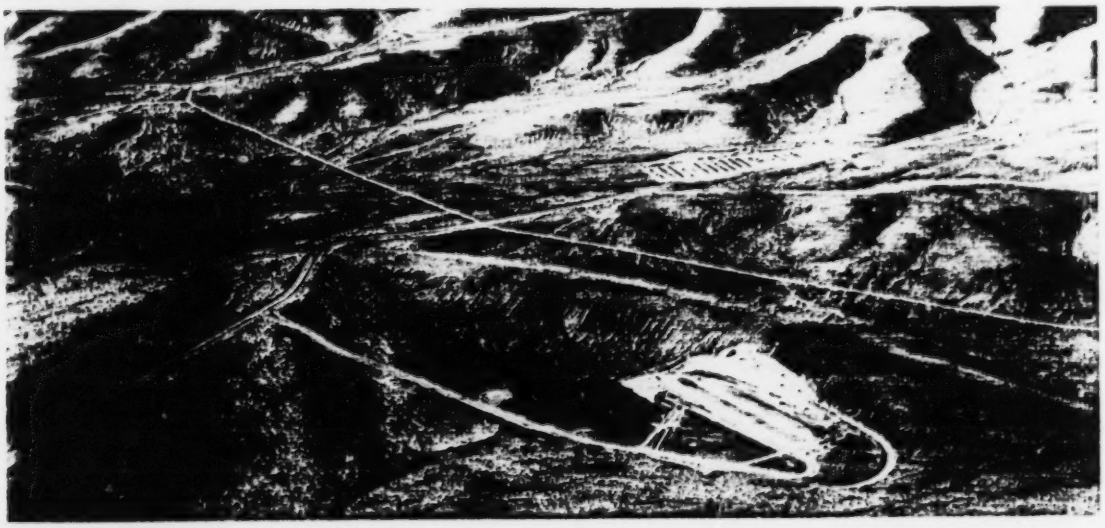


This machine handles waste remotely because of high levels of radioactivity. Containers of simulated waste are being inserted into the salt walls at WIPP.



Cutaway views of drums.

Another possible site for a waste disposal facility is located at Yucca Mountain, Nevada. Yucca Mountain offers a very dry location, a deep water table (1,700 feet), and a solid rock formation. Studies are ongoing to determine if Yucca Mountain would make a suitable location for a permanent repository. These studies include evaluating the rock formations' resistance to shock, the repository's potential socioeconomic impact, and protection of the endangered desert tortoise. If Yucca Mountain is found to be suitable for a repository, waste disposal would begin sometime in the next century.



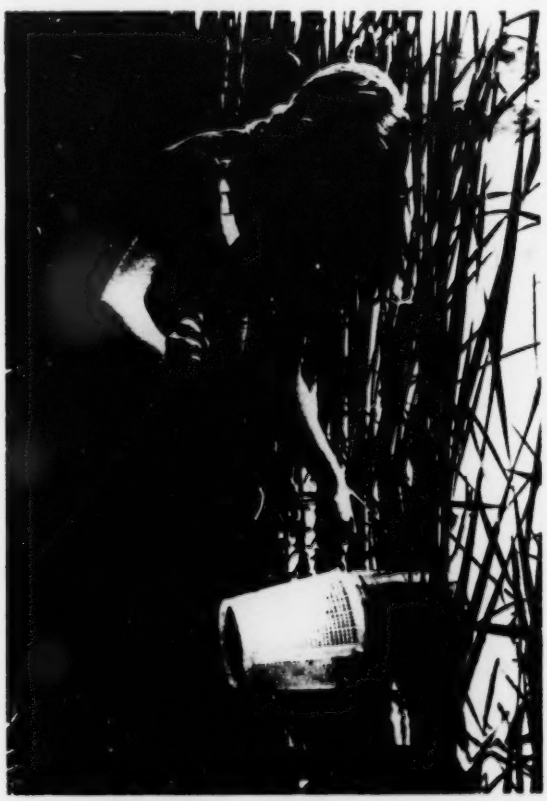
Yucca Mountain, Nevada, where studies are currently underway to determine its suitability for the permanent disposal of spent nuclear fuel and high-level radioactive waste.

Cutaway diagram of what the proposed facilities at Yucca Mountain may look like.

What Are Corrective Activities?

EM facilities may not meet current environmental regulations. They may be active, where DOE conducts activities, or inactive, in the process of being cleaned up. Corrective Activities bring these facilities into compliance with all Federal, State, and local regulations.

DOE is currently out of compliance with Federal, State, and local environmental requirements at many of its sites. Corrective Activities are actions and projects designed to bring DOE into compliance. They also include those actions and projects identified by operations offices as out of compliance with near-term regulatory requirements.



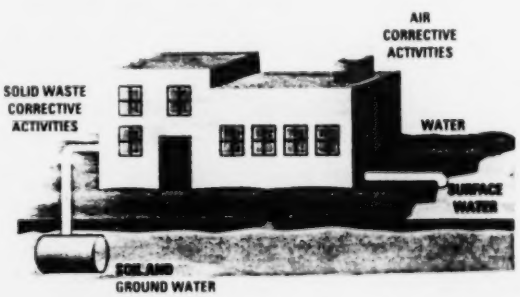
This student is taking water samples as part of the Oak Ridge summer camp for Laboratory Cooperative Science Education.

There are three types of Corrective Activities:

Water Corrective Activities reduce or eliminate the release of contaminants to the surface water regulated under the Clean Water Act.

Air Corrective Activities reduce or eliminate releases of contaminants to the atmosphere. These releases occur through regulated sources, such as stacks and exhaust vents, and must comply with the Clean Air Act.

Solid Waste Corrective Activities bring solid waste management operations that may or may not have contaminated the soil and ground water into compliance with Federal, State, and local solid waste and ground-water requirements.



Corrective Activities cover the full range of environmental releases: 1) air, 2) surface water, and 3) soil and ground water (solid waste).

Office of Environmental Restoration

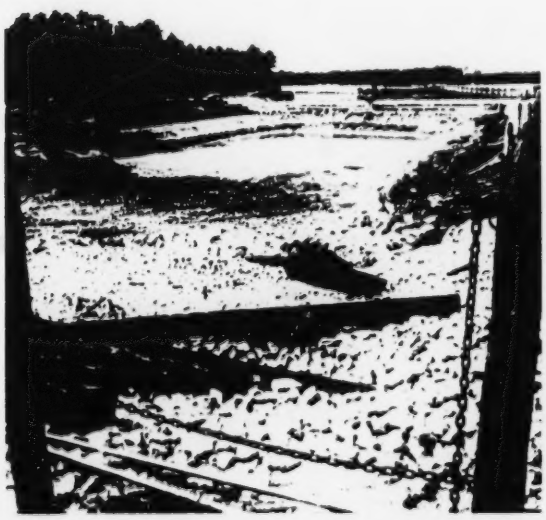
We must deal with contamination at and around our sites. Restoring the environment to safe conditions includes Remedial Actions and Decontamination and Decommissioning (D&D).

The goal of Environmental Restoration is to ensure that risks to human health and safety, and to the environment are either eliminated or reduced to safe levels. Environmental Restoration consists of two sets of activities: Remedial Actions and D&D.

What is the Difference Between Remedial Actions and D&D?

Remedial Actions deal with cleaning up inactive sites, which are facilities that are no longer operating. Such activities are mostly concerned with contaminated soil and ground water but may also deal with surface-water contamination or with tanks, buildings, and structures at either active or inactive sites.

D&D deals with keeping inactive buildings safe until they can be decontaminated, entombed, dismantled and removed, or converted to another nonnuclear use. D&D activities are concerned with facilities such as reactors, hot cells, processing plants, storage tanks, and other structures. There are approximately 500 contaminated facilities included under D&D activities.



These seepage basins at the Savannah River Site, South Carolina, contained chemicals and radioactive materials.

Remedial actions concluded with placement of a layer of topsoil and then sowing grass seed.

Office of Technology Development

As we pursue the 30-year cleanup goal, we know that current technology can't resolve future technical issues. We continually look for better, safer, and more efficient and economical methods.

What Are the Goals of Technology Development (TD)?

To become the international leader in technology development for environmental restoration and waste management operations;

To expand the talent pool for site cleanup and waste management through significant support of education in science and technology; and

To provide effective support to EM in the identification and resolution of technology needs.

Researchers at Argonne National Laboratory have designed a "Meissner Motor" using super-conducting materials. The superconductors are activated when liquid nitrogen is added.

What TD Programs Have Been Established?

The Research, Development, Demonstration, Testing, and Evaluation (RDDT&E) Program

The RDDT&E mission is to take concepts and develop them into proven methods. These methods can then be used in either the environmental restoration of inactive sites and facilities or in the waste management of ongoing operations. These technologies include:

minimizing the toxicity and volume of waste;

managing unavoidable waste more efficiently and safely;

accomplishing faster, better, cheaper, and safer remediation of waste problems; and

supporting safe, permanent disposal of waste within regulatory guidelines.

The RDDT&E Program includes three phases:

The Innovative Technology Phase stimulates new and better approaches to all aspects of environmental restoration and waste management;

The Applied Research and Development Phase supports research applied to developing environmental restoration and waste management technologies;

The Demonstration, Testing, and Evaluation Phase validates technologies by demonstrating effectiveness, cost savings, improvements, and risk-reduction potential.

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RDDT&E is organized into **Integrated Demonstrations** and programs that focus activities toward the end objective of a fully workable, faster, and cost-effective technology system. These activities involve combining technologies from the government, universities, private industry, agencies, and the general public to solve problems in areas including:

Ground Water and Soil Cleanup;

Waste Retrieval and Waste Processing;

Waste Minimization and Waste Avoidance.

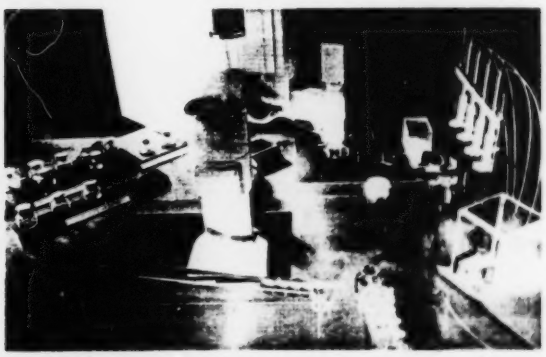
Each Integrated Demonstration will be conducted at only one site. If the new technology passes the tests, it will then be implemented at other similar sites. If for any reason the technology is proven faulty, it will not be used.

Technical Integration Program

The Technical Integration Program coordinates the sharing of successful technologies with other sites with similar problems, with other Federal agencies, industries, universities, national laboratories, and the international sector.

International Technology Exchange Program

The International Technology Exchange Program helps locate and bring back to the United States technologies from other countries that can assist with the cleanup of sites that have been used to build nuclear weapons. It also helps industries in the United States that have environmental technologies find a place to market them in other countries.



Robotic system developed for chemical analysis of soil composition.

RETRVIR (Remote Telerobotic Vehicle for Intelligent Retrieval) is a Honda All-Terrain Vehicle equipped with a 6-foot robotic arm for digging and picking up contaminated material and placing it in storage containers.

Education Development Program

Meeting the compliance and cleanup goal over the next 30 years is going to require many people with a wide variety of skills. Obviously, not everyone working toward the goal today will still be involved 30 years from now. The task of the Education Development Program is to ensure that EM's current and future work force has the skills, knowledge, and abilities to carry out its mission today and in the future. To this end, schools are encouraged to focus on environmental restoration and waste management science and technology.

Now that you know what EM is doing and why it is so important, you may want to pursue a career in environmental management to help meet the 30-year goal. To encourage minorities, women, and disadvantaged people to pursue further education in environmental programs, EM has established scholarship and fellowship programs, educational outreach programs, and pilot DOE partnership programs. Call (301) 903-7924 for more information.

Transportation

Protecting the public and the environment during shipment of radioactive and hazardous material is so important that it is covered in depth in the next section.

How Are Radioactive and Hazardous Materials Transported?

EM's Transportation Management Program ensures that material used in program activities is safely and efficiently transported. Although radioactive material makes up a small percentage of what we ship, it receives the most attention. This material ranges from slightly radioactive substances, such as uranium ore, to highly radioactive ones, such as spent nuclear fuel. Shipments containing higher levels of radioactive material must use interstate highways and beltways around major cities. State and Tribal authorities may designate an alternate route after consulting with other affected States and cities, and complying with U.S. Department of Transportation safety guidelines.

Byproducts from processing highly radioactive materials, as well as from the production of other useful radioisotopes, are shipped for use in:

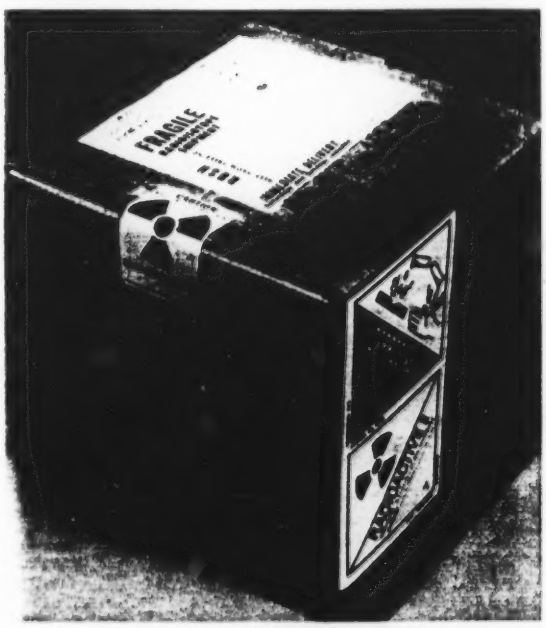
- medical treatment,
- industrial processes,
- consumer goods, and
- research programs.

The packaging requirements and strict regulations and procedures ensure safe transportation for radioactive materials. U.S. Department of Transportation regulations must be followed. These regulations include guidelines for:

- training employees,
- loading and securing the cargo,
- identifying the material through proper labels and markings,
- providing required information and emergency response contacts on shipping papers,
- maintaining the vehicles,
- selecting the best route, and
- selecting qualified carriers and drivers.

EM uses a system to protect workers, the public, and the environment from the potential hazards of radioactive material. The packages are specially designed to protect their contents during normal transport should an accident occur, rather than relying on special handling, routing, or the performance of transportation workers. There has never been a death or injury due to the radioactive nature of the cargo. The packaging and shipping method depends on the amount and level of radioactivity.

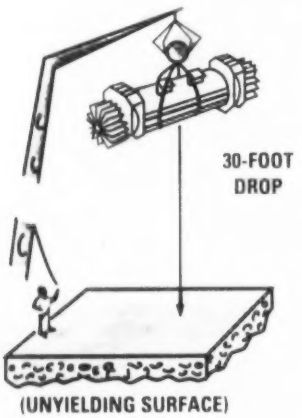
Type A packages are boxes made of wood or sturdy fiberboard used for shipping small quantities of low-level radioactive material. The boxes are tested to withstand being sprayed with water, dropped, compressed, punctured, and other ordinary handling mishaps. Type A packages are used to transport radiopharmaceuticals and low-level waste throughout the United States.



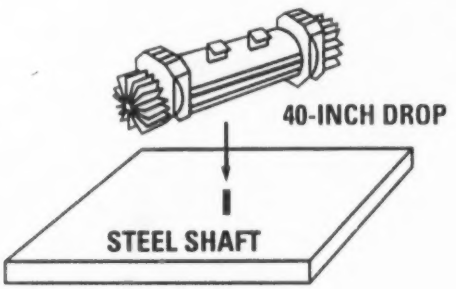
Type A packages contain small amounts of radioactive material and are designed to withstand normal conditions of transport.

Type B packages include steel drums and impact-resistant steel containers called ***casks***, which are heavily shielded. They are used for shipping highly radioactive materials for safe transport or disposal to sites approved by the Environmental Protection Agency or the Nuclear Regulatory Commission. They must be able to withstand stringent tests.

In addition, TMD also supports an emergency preparedness program that coordinates DOE-wide policies and activities for transportation incidents. This program also supports regional emergency response workshops for DOE, State, and local public safety employees. Another part of the TMD program is a safety tracking and communications system called TRANSCOM that monitors the movement of specific radioactive material shipments.

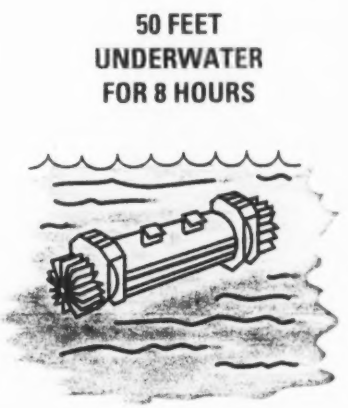


Free Drop test.



Puncture test.

Thermal test.

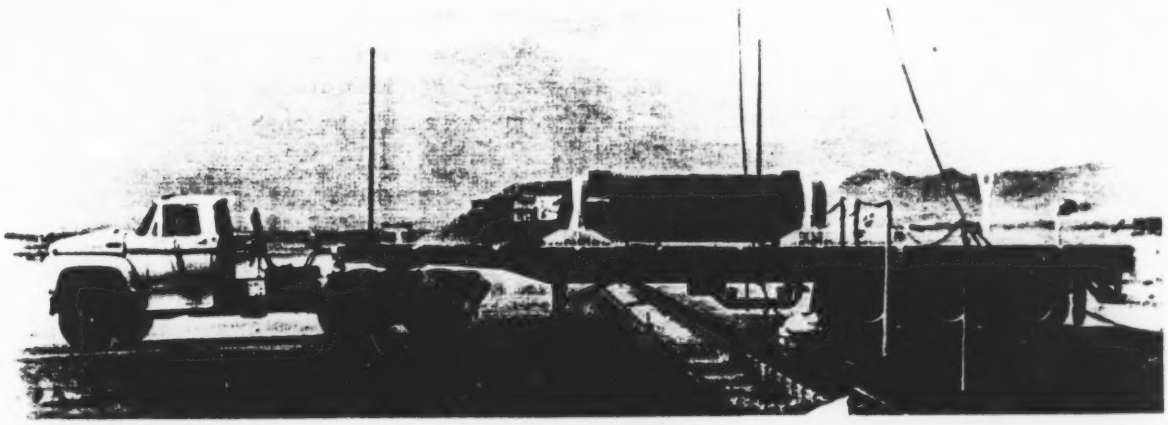


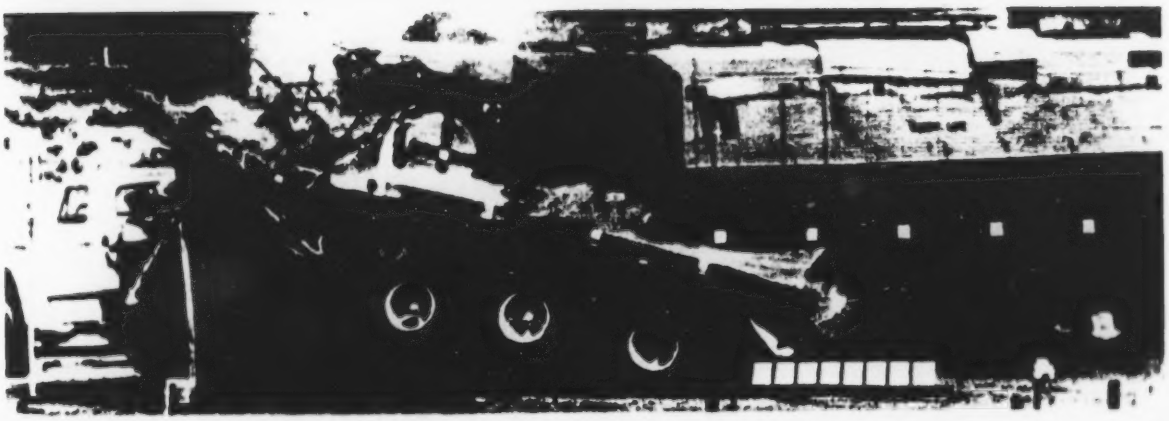
Immersion test.

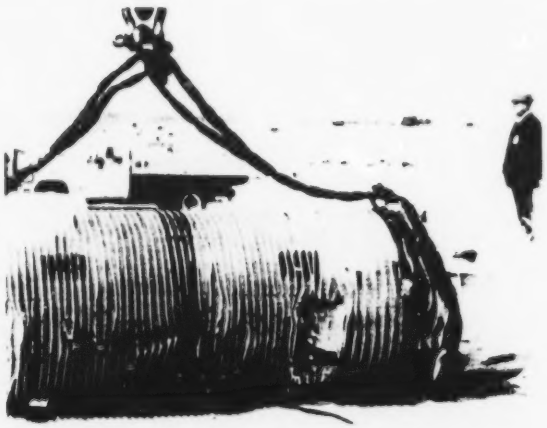
The **Transportation Management Division's (TMD)** research and development program continually works on developing, testing, and improving new transportation systems and packaging designs. It also develops and maintains computer programs to assess the risks and consequences of transporting radioactive material, and maintains facilities and equipment for testing and modeling package designs.

These activities demonstrate EM's commitment to protect the health and safety of the public and the environment during shipment of radioactive and other hazardous material and waste.

What would happen if a truck carrying simulated radioactive waste in a type B package stopped on a railroad track and was struck by a train going 80 mph? See for yourself...







Though the locomotive was destroyed, the cask was only slightly dented.

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Office of Facility Transition and Management

Transforming a DOE site from production to cleanup and nonnuclear use takes careful planning and worker retraining. Because this task is so important, we created this office.

What Is Facility Transition?

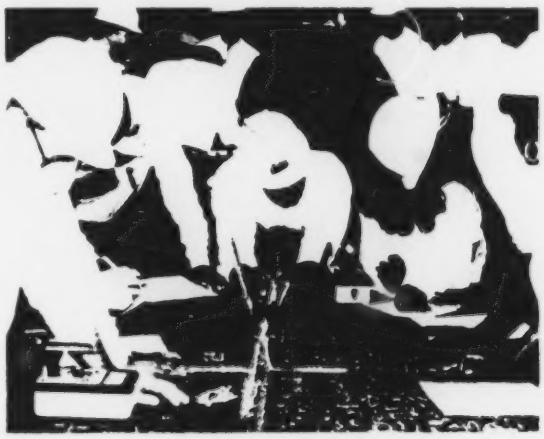
Because of the recent changes in global politics, there is far less need for the United States to produce nuclear weapons. As a result, DOE is faced with the problems of facilities and equipment that will no longer be used for weapons production and a work force that needs to be retrained. The term "transition" is defined as the set of steps a facility undergoes between the end of its original mission and the transfer to its final use. The Rocky Flats Plant in Colorado and the Hanford Site in Washington are in the process of transition.

In 1992, the Office of Facility Transition and Management was formed as a separate organization so that funds for transition and training would no longer be taken from ongoing EM projects.

The Office of Facility Transition and Management faces several challenges:

- To make contaminated buildings and facilities environmentally safe;
- To provide training opportunities in EM programs for the current work force;
- To work with communities in deciding future uses of the facilities; and
- To carry on economic development of these sites in a cost-effective way.

As the mission of DOE changes from production to environmental cleanup, the skills of the work force need to change. EM will retrain as many workers as possible. For example, in 1991, workers at Fernald participated in several three-week programs of lectures and hands-on training in environmental cleanup.



Workers at training sessions are taught to perform a radiological survey for contamination.

EM is also committed to providing assistance to displaced workers through academic and vocational counseling, individualized training programs, and a variety of educational opportunities.

As a member of a community near a transition site, you can have an active part in deciding the future of that site. Depending on what its pre-cleanup mission was, the site may even be used as a public area. Buildings at Rocky Flats in Colorado that were used in nonnuclear activities might be made available for private use, providing jobs and commerce for the local community. The Office of Facility Transition and Management will work closely with the public and local planners to decide the future of surplus DOE sites.

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EM Educational Opportunities

We encourage students to pursue careers in math and science and to become part of DOE cleanup efforts. EM offers many undergraduate and graduate student programs.

EM education programs serve a dual purpose: to provide EM with highly talented and motivated individuals who are educated and trained for the future, and to spark student interest. Described below are several fellowship and scholarship opportunities for undergraduate, graduate, and faculty applicants.

Precollege Programs

- **EM Precollege Analytical Chemistry (EMPAC) Program** provides students with an opportunity to live on campus and attend a college-level chemistry course for credit. Call (801) 278-0799 or write: Associated Western Universities, Inc., EMPAC, 4190 S. Highland Drive, Suite 211, Salt Lake City, UT 84124.
- **WM Education Research Consortium - Environmental Fellows Program** provides a nine-month educational session and three-month work experience on issues related to ER and WM. Call (505) 646-2038 or write: Environmental Fellows Program, Box 30001, Dept. 3805, Las Cruces, NM 88003.

Scholarship/Undergraduate Programs

- **ER and WM Scholarship Program** supports undergraduate science and engineering students completing their degrees. Requirement: U.S. citizen and completion of a summer internship at a DOE laboratory. Call (615) 576-9278 or write: ER/WM Scholarship Program, Oak Ridge Institute for Science and Education, P.O. Box 117, Oak Ridge, TN 37831.
- **EM Career Opportunities Research Experience (EMCORE) Undergraduate Scholarships** support science and engineering students after completion of sophomore year. Requirement: U.S. citizen or permanent resident. Write: Associated Western Universities, Inc., EMCORE Program, 4190 S. Highland Drive, Suite 211, Salt Lake City, UT 84124.
- **ER and WM National Hispanic Scholarship Fund** provides support for undergraduate Hispanic-American engineering and environmental program students. Call (505) 845-4519 or write : U.S. DOE Albuquerque Operations Office, P.O. Box 5400, Albuquerque, NM 87115.
- **EM Career Opportunities for Minorities (EMCOM) Program** provides undergraduate through post-doctoral degrees. Faculty provides research at participating DOE laboratories. Requirement: faculty and students of Historically Black Colleges and Universities. Call (801) 278-0799 or write: Associated Western Universities, Inc., EMCOM Program, 4190 S. Highland Drive, Suite 211, Salt Lake City, UT 84124.

Faculty and Fellowship Programs

- **ER and WM Fellowship Program** awarded to full-time, advanced degree engineering and science students. Requirement: U.S. citizen and completion of a course at a DOE facility. Call (615) 576-9655 or write: EM/WM Fellowship Program, Oak Ridge Institute for Science and Education, P.O. Box 117, Oak Ridge, TN 37831-0017.
- **EM Career Opportunities Research Experience (EMCORE) Graduate Fellowships** support science and engineering graduate students and faculty teaching and researching EM/WM work at participating DOE laboratories for 10 weeks to 10 months. Call (801)278-0799 or write: Associated Western Universities, Inc., EMCORE Program 4190 S. Highland Dr., Suite 211, Salt Lake City, UT 84124.
- **Internship Program in Radioactive WM** is available for Vanderbilt University engineering and science students. Requirement: summer course at a DOE facility. Call (615)322-2697 or write: Radioactive WM Internship Program, Vanderbilt University, P.O. 1596, Station B, Nashville, TN 37235.
- **ER/WM Distinguished Young Faculty Award Program** is awarded for full-time, doctoral faculty with a tenure travel appointment. Call (615) 576-1078 or write: Oak Ridge Institute for Science and Education, P.O. Box 117, Oak Ridge, TN 37831.

Involvement by the public in EM activities is important to us at DOE. You can get involved through DOE and independent organizations. The future depends on you.

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Credits

We hope that this document helped explain what has happened over the past 40 years, what we're doing now to correct the problems, and the importance of your role in helping to meet the 30-year goal. The *Student Edition of the Environmental Restoration and Waste Management: An Introduction* is the result of the EM Primer Contest, one of several ongoing education programs within the Environmental Restoration and Waste Management's Office of Planning. Other programs that support public participation efforts include the Student Edition of the Five-Year Plan, the Student Review of the Five-Year Plan, and the Practical Applications for Young Scientists Program (PAYS). Student efforts and comments are used in conjunction with these programs to support EM planning efforts. If you would like to find out more about these important programs contact:

Environmental Restoration and Waste Management, Office of Planning
U.S. Department of Energy
1000 Independence Ave., S.W.
Washington, D.C. 20585
(202) 586-4373

We thank all of the student teams for allowing us to review their documents and learn from their efforts. We would like to give special thanks to the team from Connell High School for providing the inspiration for our cover and to the team from Cheyenne High School for the statement by Alan DeVoe.

Cheyenne High School, North Las Vegas, Nevada
Connell High School, Connell, Washington
Evans Comprehensive High School, Evans, Georgia
Karns High School, Oak Ridge, Tennessee
Kiona-Benton City High School, Kiona-Benton City, Washington
Shelly High School, Shelly, Idaho

Local citizen advisory groups welcome your support and involvement. To find out how you can get involved, please contact the Public Affairs Office through your DOE Operations Office or call DOE Headquarters at (202) 586-4373.

Albuquerque, NM	(505) 845-6202
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Fernald, OH	(513) 648-3131
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San Francisco, CA	(510) 637-1809
Savannah River, SC	(803) 725-2889

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